Faculty of Manufacturing Engineering

REGRESSION MODELS OF MUSCLE ACTIVITY, PSYCHOPHYSICAL EXPERIENCE AND HEART RATE IN MANUAL LIFTING TASK

Noor Rawaida binti Omar

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REGRESSION MODELS OF MUSCLE ACTIVITY, PSYCHOPHYSICAL EXPERIENCE AND HEART RATE IN MANUAL LIFTING TASK

NOOR RAWAIDA BINTI OMAR

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DECLARATION

I declare that this thesis entitled "Regression Models of Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting Task" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Manufacturing Engineering.

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I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in terms of scope and quality as a partial fulfillment of Master of Manufacturing Engineering.

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DEDICATIONS

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ABSTRACT

The mismatch between human and work system can influence workers' efficiency, productivity, and occupational health. Improper design of manual materials handling (MMH) tasks in manufacturing industry is one of the causes of this mismatch, which is one of risk factors leading to various occupational injuries such as back pain, neck pain, and sprain and strain in the muscles. Engineers and managements require a regression model to design work process related to MMH tasks. The regression model must be able to predict the effects of MMH parameters such as load mass, lifting height, and twist angle to workers' physical charateristics including muscle activity, psychophysical experience, and heart rate. Existing studies, guidelines and tools related to industrial ergonomics have shown a limitation in predicting the effects of MMH on human pysical. Thus, a development of regression model for designing MMH that can meet above requirement is needed. The aim of this study is to develop regression models of muscle activity, psychophysical experience, and heart rate with respect to load mass, lifting height, and twist angle for the purpose of predicting and redesigning the MMH processes. This study performed questionnaire survey at industries, experiments on manual lifting task using full factorial design of experiment, develop and validate regression models through statistical analysis. In experimental task, ten female with equal numbers of male subjects with no musculoskeletal disorders were paid to perform eight lifting tasks with five replications for each task. Results of this study found that the developed regression models able to predict the electromyography (EMG) signals in the erector spinae and biceps brachii, psychophysical experience (Borg Scale), and heart rate (beats per minute) when the load mass in the range of 5 kg to 15 kg, 55 cm to 130 cm of lifting height, and twist angle ranging from 0 degrees to 90 degrees. Based on the developed regression models, this study concluded that the load mass contributed the greatest effect to muscle activity, psychophysical experience, and heart rate. It is expected that the use of developed regression models may facilitate the MMH process design through the optimization of muscle activity, psychophysical experience, and heart rate. Hence, better compatibility of MMH task and worker may be achieved resulting in efficiency, productivity and occupational health improvement.

ABSTRAK

Ketidakpadanan antara manusia dan sistem kerja boleh mempengaruhi kecekapan pekerja, produktiviti dan kesihatan pekerjaan. Aktiviti mengangkat secara manual yang tidak dilakukan secara ergonomik dalam industri pembuatan merupakan salah satu punca kepada ketidakpadanan ini, yang diketahui sebagai punca kepada pelbagai kecederaan pekerjaan seperti sakit belakang, sakit leher, terseliuh dan tegang otot. Jurutera dan pihak pengurusan industri memerlukan satu model regrasi untuk merekabentuk proses kerja berkaitan aktiviti angkatan manual. Model tersebut mesti boleh meramal kesan faktor-faktor aktiviti angkatan manual seperti berat beban, tinggi paras angkatan dan sudut pusingan terhadap ciri-ciri fizikal pekerja termasuk aktiviti otot, pengalaman psikofizikal dan kadar denyutan jantung. Kajian, garis panduan dan alat berkaitan ergonomik industri yang sedia ada mempunyai batas untuk meramal kesan aktiviti angkatan manual terhadap fizikal pekerja. Maka, satu pembangunan model regrasi untuk merekebentuk aktiviti angkatan manual yang dapat memenuhi kriteria di atas adalah diperlukan. Tujuan kajian ini adalah untuk merangka model regrasi untuk meramal aktiviti otot, pengalaman psikofizikal dan kadar denyutan jantung terhadap berat beban, tinggi paras angkatan dan sudut pusingan untuk merekebentuk semula proses aktiviti angkatan manual. Kajian ini telah menjalankan kaji selidik di tempat kerja dalam industri, eksperimen terhadap aktiviti angkatan manual menggunakan reka bentuk faktorial penuh dan model regrasi ini akan dirangka dan disahkan dengan menggunakan analisis statistik. Sepuluh subjek perempuan dan sepuluh subjek lelaki yang sihat tubuh badan dan bebas dari masalah otot berangka dibayar untuk melakukan lapan aktiviti angkatan manual. Setiap angkatan manual akan diulang sebanyak lima kali. Hasil kajian mendapati model regrasi yang dibangunkan ini dapat meramal isyarat electromyography (EMG) di otot erektor spina dan bisep brachii, pengalaman psikofizikal (Skala Borg), dan kadar denyutan jantung apabila berat beban diantara 5 kg hingga 15 kg, 55 cm hingga 130 cm tinggi paras angkatan dan sudut pusingan diantara 0 darjah hingga 90 darjah. Berdasarkan model regrasi yang dibangunkan, kajian ini membuat kesimpulan bahawa berat beban, menyumbang kesan yang paling besar terhadap aktiviti otot, pengalaman psikofizikal dan kadar denyutan jantung. Kajian ini menjangkakan model regrasi yang dibangunkan ini dapat memudahkan proses rekabentuk mengangkat secara manual melalui pengoptimunan aktiviti otot, pengalaman psikofizikal dan kadar denyutan jantung. Maka, keserasian yang lebih baik dapat dicapai di antara aktiviti mengangkat secara manual dan pekerja supaya dapat meningkatkan kecekapan, produktiviti dan kesihatan pekerjaan.

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